a Light on this obſcure Subject. I am, with very great Reſpect,

Dear Sir,

Tooting, Feb. 15. 1745-6.

Your faithful Friend,

and obliged humble Servant,

H. Miles.

XVII. *An Account of a Book intituled*, De quamplurimis Phoſphoris nunc primum detectis Commentarius. *Auctore* Jac. Barthol. Beccario. *Printed in* 4to. *at* Bolognia, 1744. *Extracted and tranſlated from the* Latin *by* W. Watſon, *F. R. S.*

Read Feb. 27. 1745-6.

THE ingenious Author, in the Work before us, does not treat expreſly of thoſe Productions of the chemical Art, which we uſually call *Phoſphori*, but principally of ſuch Subſtances, whether natural or artificial, which imbibe the Rays of Light in ſuch Quantities, and in ſuch a Manner, as to appear luminous for a Time, even in abſolute Darkneſs.

Before I enter upon the Subject Matter of this Treatiſe, I muſt take notice of the *Apparatus* made uſe of in theſe Inquiries. Our Author cauſed a wooden Box to be made, large enough either to ſit in, or ſtand in upright; yet not ſo large but he might with Eaſe be carried to any Place the moſt convenient

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for his Obſervations. In this Box was a little Window, in which a cylindrical Tube was fitted ſo exactly, that no Light could be admitted but through the Tube, in which there was an *Apparatus* ſo adapted, that the Perſon within could place any Object proper for Obſervation in ſuch a Manner, as to receive as much Light as it could contain, and then to turn it inſtantly towards his Eye, without admiting the leaſt Ray of Light, beſides that brought in by the Object. The Inſide of this Box muſt be abſolutely dark; without which Caution many of the Attempts would be unſucceſsful; becauſe the Light in many of the Subjects was neither very lively nor very laſting. Therefore it was neceſſary alſo, that the Eyes of the Obſerver ſhould be as free as poſſible from the Impreſſions of former Viſion: So that it were proper to make theſe Obſervations immediately after Sleep, or to keep the Eye you intend to make uſe of ſhut at leaſt half an Hour before you enter the Box. A Proof to know whether your Eye is properly diſpoſed, will be expoſing a Piece of white Paper to the Light in the Tube, and then being able to perceive its Form and Colour when turned towards you in the Box.

Our Author divides the *Phoſphori* into ſeveral Kinds; ſome of which ſhine of themſelves naturally, as the Glow-worm and Dates; or adventitiouſly, as the Fleſh of Animals, which moſt probably ariſes from a Degree of Putrefaction, ſometimes too ſlight to be obvious to our Senſes. Other Bodies become luminous by Attrition, Heat, the free Acceſs of Air, and, laſtly, by imbibing and retaining the Rays of Light. Thoſe Bodies that are luminous by Attrition, are amongſt others, ſome Diamonds, and the Hairs of Animals; by Heat, ſeveral Sorts of Gems, and Mountain Cryſtals; from the free Acceſs of Air, the *Phoſphori* of *Kraft* and *Homberg*; from the Aſpect of Light, the *Bolognian* luminous Stone, the Preparation by *Chriſtian Adolphus Baldwin* of Chalk diſſolved in Spirit of Nitre, as well as ſeveral others diſcovered by the late Monſieur *Du Fay*, who found, that whatever Subſtances would, by Calcination, be converted into a *Calx*, or whoſe Concrete, from a Solution in the Acid of Nitre, would bear Fire enough to become red-hot, theſe Bodies were adapted to imbibe and retain Light.

The greateſt Number of *Phoſphori* are of the laſt-mention'd Kind, and theſe are principally the Subjects of this Treatiſe. Some of theſe are natural, others artificial; but of theſe laſt the Preparation is ſo ſlight, as not to change the Nature of their conſtituent Parts. The natural *Phoſphori* are either foſſil, vegetable, or animal. The foſſil are, though very different in Degree, ſome Sorts of Earths, white Sand, Lime-ſtones, *Stalactites*, and ſeveral other figured Stones, Iſland Cryſtals, Flints, ſome Species of Agates, white Arſenic; but no ſort of Metals, metallic or ſulphureous Bodies, as Jet, Amber; except the before-mention'd Arſenic. On the other hand, Salts imbibe Light, provided they are diveſted of every metallic Principle; otherwiſe not, though pellucid as poſſible. For this Reaſon, none of the Vitriols will imbibe Light; but other Salts will, tho' with a conſiderable Difference as to Quantity; for *Sal Gem.* and Rock-Salt imbibe very little; Sea-Salt, if dry, and in Cryſtals, much more; and, in like

manner,

manner, *Sal. Ammoniac.*; more yet, *Sal catharticum* and Nitre; weak in the *Natron* of the Ancients, and Alum; but brighteſt of all in *Borax.*

In the vegetable Kingdom we find very few *Phoſphori*; that of dry rotten Wood is weak, and not laſting; it appears chiefly upon the Edges and Inequalities of the Surface. But this is moſt remarkable in the rotten Wood of the Fir-tree, and ſome others, where in the dark you ſee ſhining Spots as big as Tares; whereas, in full Light, the whole Surface appears alike. Some few Barks are luminous, but not conſiderably ſo; but no Fruits, Seeds, or their Meals. Cotton appears very bright, and the Cryſtals of Tartar; but fine Loaf Sugar appears the moſt luminous of all, both without and within. Gums and Reſins retain no Light.

There is a vaſt Variety of *Phoſphori* in the animal Kingdom, ſuch as the Bones and Teeth; to theſe may be added the Shells of Fiſh, Egg-ſhells, the human *Calculus,* Bezoar, and in whatever Parts of Animals the terreſtrial Principle is very predominant. But where there is a conſiderable Quantity of oily Matter, as in the Hoofs, Horns, and Feathers, no Light is manifeſt.

The Author, having gone through the natural *Phoſphori,* propoſes ſome Queries concerning them; of which the firſt is, In what and how great a Light the Object ought to be placed? He tried different *Phoſphori* in different Degrees of Light, and found them imbibe moſt Light from the Sun itſelf; next in Quantity, when the Sky was clear; and the leaſt in foggy Weather. Theſe Experiments ſhould be made in the open Air, and not in a Houſe with the glaſs Windows ſhut; becauſe many Bodies appear luminous,

luminous, when the Light has come directly to them, which will not have that Appearance when the Light has paſſed through the Glaſs. He laſtly tried what Light they would imbibe from very bright Flame, and found, that Alabaſter itſelf, which is ſaturated more than any Subſtance by the Sun's Rays, imbibed exceedingly little. The next Query is, how long theſe Bodies ſhould remain in the Light to be ſufficiently ſaturated? Four or five Seconds were found the utmoſt Length of Time required for that Purpoſe. The other Query is, How long the received Light will continue in theſe *Phoſphori?* It does not laſt the ſame Time in all; but continues more or leſs, from 2 Seconds to 8, in proportion to the Strength of the *Phoſphorus*, and the Quantity of Light received.

We paſs now to thoſe *Phoſphori*, which are produced by Art; and, firſt, to them which are made by the Maceration of Plants alone, and without any Fire; ſuch as Thread, Linen Cloth, but, above all, Paper. The luminous Appearance of this laſt is greatly increaſed by Heat. This is confirmed by two Experiments: The firſt is, by expoſing the Paper, ſpread upon an iron Grate, to the naked Fire, yet not near enough to ſcorch it, and then laying a warm Brick thereon to retain the Heat; by which means it was obſerved, that where the Paper was not ſkreened by the iron Grate, it was moſt luminous; ſo that, by the Lights and Shades, you might diſtinguiſh in the dark the Image of the iron Grate a conſiderable Time. The other Experiment is the Application of the Paper to a Plate of warm Braſs; from which, when in the dark, you might very eaſily, by its being leſs luminous,

minous, diſtinguiſh the Margin of the Paper, that had not been warmed by the Braſs.

The Author proceeds to take notice of thoſe *Phoſphori* which become ſo by the Aſſiſtance of Fire. But the Fire here ſpoken of is not great enough to diſſolve their conſtituent Parts, but only ſuch as may affect the external Parts of their Texture, and that but gently; ſo that the Proceſs here mentioned is only drying or roaſting. For it is not the watry or the ſaline Part in Bodies which is torrefied; but the oleaginous, wherewith many Vegetables, and moſt Animals, abound.

The white Fleſh of Animals, ſuch as that of Chickens, becomes a *Phoſphorus* by roaſting, as well as the Tendons, and whatever Parts of Animals become glutinous by boiling, ſuch as Carpenter's Glue, Iſinglaſs; to theſe may be added Cheeſe. Bones, tho' they imbibe Light without any Preparation, have that Property in a much greater Degree when burnt, and their luminous Appearance is much more lively. But Roaſting has not this Effect upon Feathers, Hoofs, Horns, or Whites of Eggs. The ſame Operation, which produces ſeveral *Phoſphori* from the animal Kingdom, gives alſo ſeveral from the vegetable. Thus, by gently toaſting, Gums, as Myrrh, Gum Tragacanth, and others, appear luminous, tho' different in Degrees; and this Light is clear, in proportion to the gentle Evaporation of their aqueous Parts. By this Treatment, Nuts of every Kind, Pulſe, Corn, Coffee-Berries, Meal, Bread, and Wafers, alſo become *Phoſphori*. Turpentine, Amber, and ſome Reſins, require more Fire before they imbibe Light; ſo that you muſt diveſt them of their Acid, and their light

light ethereal Oil, to make them appear luminous. But here great Care muſt be taken that they boil no longer than from being white they turn yellow; for if you proceed longer, your Labour is loſt.

It is neceſſary that you ſhould be acquainted, that thoſe *Phoſphori*, which are produced by Torrefaction, ſoon loſe their Power, which, perhaps, neither Time, nor a thorough Diſſolution of their Parts, can deprive the natural ones of. In general, as long as the *Phoſphori*, gained by Torrefaction, preſerve their Power, their Light is more ſharp and ſtriking, but the natural, more weak. But thoſe that are gained by Calcination, and *Baldwyn*'s *Phoſphorus*, ſeem to poſſeſs both the ſtriking Light of thoſe gained by Torrefaction. and the weaker Light of the natural *Phoſphori:* The laſt they preſerve a long time, but the former is loſt by degrees much ſooner. The well calcin'd Aſhes of Plants, or rather their terreſtrial Parts remaining after the Solution of their fixed Salts by waſhing, and neutral Salts, continue *Phoſphori* after many Years. So that, as far as we can judge, the luminating Power which is gained by Calcination, tho' not ſo intenſe, continues perpetual; whereas that gained by Torrefaction always decreaſes, and in a very little while is no longer viſible. Some even, by this Method, continue to imbibe Light much longer than others. Gum *Arabic*, which continues longeſt, laſts ſix Days; Bread, not one; and Coffee, only a few Minutes. However, at any time, by a freſh Torrefaction, you may recover theſe languid *Phoſphori*; in which Property they have great Likeneſs to the *Bolognian* Stone, and other *Phoſphori* prepared by Art. The *Phoſphori* gained by Torrefaction, as well as that of *Bolognia,* will not imbibe Light, while they are warm; and this laſt does not appear ſo luminous when firſt prepared, as when it has been ſo ſome time.

The natural *Phoſphori* do not differ only in the before-mention'd Particulars, but alſo in the Colour of the Light itſelf. The Light of the natural generally appears either perfectly bright, or ſomewhat inclining to yellow: The artificial produces a red, and ſometimes a brown Light; but there are ſome Exceptions to both theſe Rules. From theſe different Appearances, the Author conjectures, that there are two Sorts of Fire ariſing from different Principles; *viz.* that in torrefied Subſtances, from a ſulphureous, and that of the natural, from a terreſtrial Principle.

In obſerving a Piece of *Lapis Tutiæ,* which was rough and unequal on its convex Side, ſmooth and ſomewhat poliſhed on the concave; he found, to his Surprize, that the rough Side was luminous, and the ſmooth one not. He was very deſirous of inveſtigating the Cauſe of this Appearance. He remember'd that ſome poliſh'd Marbles did not imbibe Light, or very little, and that at their Edges; but, having loſt their Poliſh, they did admit and retain it. He therefore conjectures, that Bodies, according to the Diſpoſition of their Surfaces for the Reflection of the Light, either ſuffer or prevent its Entrance into them. If this Poſition holds good in the Reflection, why ſhould it not with regard to the Refraction? Our Author produces two Experiments, which he apprehends not foreign to the preſent Purpoſe; but is yet making others, for his further Satisfaction. He expoſed a glaſs Bottle full of Well-Water to the Light, and, as ſoon as poſſible, obſerved it in the dark. As he expected, it imbibed no Light. Upon pouring into it ſome Oil of Tartar, it became turbid and whitiſh, from the Well-Water being uſually impregnated with calcarious Matter. Upon obſerving it then in the dark, after having been expoſed as before, it retained enough of a pale Light to diſtinguiſh the Shape of the Bottle. In a Bottle of Rain-Water he diſſolved ſome Talc; which Stone, by rubbing, will diſſolve in Water as Salts do, without rendering it opaque; to this Solution he added Oil of Tartar, and this Mixture was luminous as the preceding. He therefore concludes, that ſo long as earthy Corpuſcles are very ſmall, ſeparate, and agreeing in their Surfaces with the Water in which they float, they readily tranſmit the Light they receive; for which Reaſon it is impoſſible they ſhould retain Light enough to appear luminous in the dark. But, by the Affuſion of the ſaline Principle, the earthy Corpuſcles unite with the Water and Salt; and from the Union of theſe Principles the Mixture grows thick, whereby the ready Tranſmiſſion of Light is prevented; ſo that, if this Mixture is without Colour, or any thing metallic, the Light will be ſtopped long enough to be viſible in the dark. But if, inſtead of Oil of Tartar, you add Sugar of Lead, the Mixture will be turbid, but retain no Light. In theſe two Experiments the Water becomes a *Phoſphorus*.

Gems, Cryſtals, and Glaſs, whether whole, or powder'd ever ſo fine, retain no Light; ſo that neither their Tranſparency nor Whiteneſs contribute to their becoming luminous in the dark. Of ſeveral Diamonds, in all Appearance perfectly the ſame, ſome were very luminous, others not at all. Of many opaque Subſtances, whether rough, poliſhed, or finely powder'd, ſome were luminous, others not. So that it appears, that not only the external, but the internal Texture of Bodies alſo, may conduce ſometimes to their being luminous.

From the preceding Experiments, the Author is led to make ſome Inquiries into the Cauſe of this luminous Appearance; and takes notice, that almoſt all Bodies, by a proper Treatment, have that Power of ſhining in the dark, which, at firſt, was ſuppoſed to be the Property of one, and afterwards only of a few. How this is brought about, is not very eaſy to ſolve. If we ſuppoſe with ſome (to which our Author, in ſeveral Paſſages of this Work, ſeems not averſe), that the Light from a luminous Body enters and abides in the *Phoſphori*, we ſhall find ſomewhat new to admire in Light itſelf. It is no new Opinion, that this Fluid conſiſts of very fine Particles, which are continually darted forth from a luminous Body, in all Directions, with a very great Velocity: But it has by nobody been laid down hitherto, that theſe Particles are not diſſolved by the Violence of their Agitation, not diſperſed, nor immediately ceaſe to exiſt; but ſubſiſt ſtill, and adhere to what Bodies come in their Way, as Heat does, and are the Cauſes of Odours. If therefore the Particles of Light are not diſſolved as ſoon as they are emitted from a radiant Body, but continue ſome time, what elſe is required, but that we allow its Atmoſphere to every lucid Appearance? If the *Phoſphori* ſhine with a borrowed Light, but not with their own, and that only when put in Motion, and fired by the Rays of a ſhining Body, which

ſome

ſome Experiments ſeem to confirm, then other new Doctrines will ariſe. There muſt be then a hidden, a ſecret Principle in Bodies, to be lighted up by this moſt ſubtle Fire. There will be in the Univerſe a certain perpetual Fire from theſe *Phoſphori*; the Matter of which, tho' conſtantly diſſipated by burning, does not waſte enough to be obvious to our Senſes.

I cannot conclude my Extract of this Author, without mentioning, that his Work is the Reſult of a great Variety of very ingenious Obſervations, and of Experiments made with the utmoſt Accuracy; to which I may add, that where-ever he makes any Conjecture concerning their Cauſes, he does it with all poſſible Decency, and Submiſſion to the Judgment of the Learned.

XVIII. *A Letter from the Rev. Dr.* Miles, *F. R. S. to Mr.* Baker, *F. R. S. concerning the Electricity of* Water.

Dear Sir,

Read Feb. 27. 1745-6.

I BEGIN with a Reſolution to be merciful, and hope to keep it, eſpecially as I perſecute you again ſo ſoon; and indeed the true Reaſon of my doing it now, is that this might reach you before I have the Favour of another from you, as it relates to an Article in my laſt *.

I this Afternoon, on reflecting afreſh on Monſieur *L'Allamand's* Experiment †, reſolved to make the following

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* *p.* 79. *ſupra.*

† *p.* 59. *ſupra.*